

CLAIMS

1. An ultrasonic levitation device comprising:
a fixed part; and
5 a movable part which movably installed on said fixed part,
so that said movable part can be floated through floating surfaces by
ultrasonic vibration of said fixed part or said movable part, wherein,
thin ultrasonic vibrators are provided on said fixed part or said
movable part.
- 10 2. The ultrasonic levitation device as claimed in claim 1, wherein:
said floating surfaces are formed in sloped surfaces.
3. The ultrasonic levitation device as claimed in claim 2, further
comprising:
fixed part guides at said fixed part; and
15 movable part guides at said movable part corresponding to said fixed
part guides, wherein,
said fixed part guides are in a form of recessed or protruded shape,
and said movable part guides are in a form of protruded or recessed shape.
4. The ultrasonic levitation device as claimed in claim 2 or claim 3,
20 further comprising:
a pair of fixed part guides for guiding said movable part on the right
and left sides, wherein,
said pair of fixed part guides is provided with sloped floating
surfaces spreading in the upward direction, and
25 said movable part guides are provided with sloped floating surfaces
on the right and left sides confronting said sloped floating surfaces of said
pair of fixed side guides.
5. The ultrasonic levitation device as claimed in claim 3, wherein:
said fixed part guides are in a form of recessed or protruded shape
30 by two sloped surfaces, and said movable part guides are in a form of
protruded or recessed shape by two sloped surfaces.
6. The ultrasonic levitation device as claimed in any one claim of
claims 1 to 5, wherein:
said fixed part or said movable part further comprising piezoelectric
35 members.
7. The ultrasonic levitation device as claimed in any one claim of

claims 1 to 6, wherein:

said fixed part or said movable part is further provided with ultrasonic vibration sources by stacking piezoelectric elements.

8. The ultrasonic levitation device as claimed in any one claim of
5 claims 1 to 7, wherein:

a vibrator of said movable part makes ultrasonic vibration,

said vibrator further comprising, a vibration plate making ultrasonic vibration, and a pair of movable part guides provided on the right and left sides of said vibration plate,

10 so that the thickness of said vibration plate and the thickness of said pair of movable part guides are different from each other.

9. The ultrasonic levitation device as claimed in claim 8, wherein:

said vibration plate further comprising a piezoelectric material.

10. The ultrasonic levitation device as claimed in claim 8 or claim 9,
15 wherein:

said vibration plate and said pair of movable part guides are produced as separate parts.

11. The ultrasonic levitation device as claimed in any one claim of claims 1 to 10, wherein:

20 said movable part further comprising a movable part body integrated with said vibrator through pillar members,

in a form that said pillar members are positioned along the center axis of said vibrator.

12. The ultrasonic levitation device as claimed in claim 11,
25 wherein:

said pillar members are connected to projecting parts positioned to be projecting from ends of said vibrator.

13. The ultrasonic levitation device as claimed in claim 12, wherein:

30 the width of connecting parts between said projecting parts and said vibration plates of said vibrator is narrower than the width of said projecting parts.

14. The ultrasonic levitation device as claimed in any one claim of claims 1 to 13, further comprising:

35 sticking preventing projections at said fixed part or said movable part.

15. The ultrasonic levitation device as claimed in any one claim of claims 11 to 14, wherein:

all or part of said pillar members comprising a viscous-elastic material.

5 16. The ultrasonic levitation device as claimed in claim 1, wherein: said ultrasonic vibrators are provided by stacking piezoelectric elements.

17. The ultrasonic levitation device as claimed in claim 16, wherein:

10 said ultrasonic vibrators are provided not less than two at said fixed part or said movable part.

18. The ultrasonic levitation device as claimed in claim 17, wherein:

said ultrasonic vibrators are provided not less than three.

15 19. The ultrasonic levitation device as claimed in claim 17 or claim 18, wherein:

said plurality of ultrasonic vibrators is provided on the same circular line.

20 20. The ultrasonic levitation device as claimed in claim 1, wherein: said ultrasonic vibrators are plate oscillating devices attached to said fixed part or said movable part through pillar members.

21. The ultrasonic levitation device as claimed in claim 20, wherein:

25 said plate oscillating devices are provided with bimorph piezoelectric elements or unimorph piezoelectric elements connected to vibration plates.

22. The ultrasonic levitation device as claimed in claim 20 or claim 21, wherein:

said pillar members are provided not less than two.

30 23. The ultrasonic levitation device as claimed in any one claim of claims 20 to 22, further comprising:

ribs on said plate oscillating devices.

24. The ultrasonic levitation device as claimed in any one claim of claims 20 to 23, wherein:

35 the space between said pillar members or said ribs is set to be an integral multiple number of approximately half of a vibration wavelength.

25. The ultrasonic levitation device as claimed in any one claim of

claims 20 to 24, wherein:

said pillar members or said ribs are positioned at inner positions from outer edges of said plate oscillating devices.

26. The ultrasonic levitation device as claimed in claim 25,
5 wherein:

the space between said pillar members or said ribs and said outer edge of said plate oscillating devices is approximately quarter of or approximately multiple number of $\{1/4 + (1/2) \times n\}$ of a vibration wavelength, on condition that symbol "n" is set to be an integral number.

10 27. The ultrasonic levitation device as claimed in claim 1, wherein:
the vibrating direction of ultrasonic vibration at said fixed part or said movable part is changed, through a vibrating direction changing means.

28. The ultrasonic levitation device as claimed in claim 27,
15 wherein:

said vibrating direction changing means changes the vibrating direction of ultrasonic vibration orthogonally.

29. The ultrasonic levitation device as claimed in claim 28,
wherein:

20 the direction of main vibration changed by said vibrating direction changing means is in one direction.

30. The ultrasonic levitation device as claimed in claim 29,
wherein:

25 said vibrating direction changing means further comprising a vibrating direction changing member in a form of letter L shape.

31. The ultrasonic levitation device as claimed in claim 28,
wherein:

the direction of main vibration changed by said vibrating direction changing means is in two directions.

30 32. The ultrasonic levitation device as claimed in claim 31,
wherein:

said vibrating direction changing means further comprising a vibrating direction changing member in a form of cross shape.

35 33. The ultrasonic levitation device as claimed in any one claim of claims 27 to 32, further comprising:

vibrators provided with Langevin type ultrasonic transducers or

sheet lamination type piezoelectric elements at said fixed part or said movable part.

34. The ultrasonic levitation device as claimed in claim 33, wherein:

5 said Langevin type ultrasonic transducers or said sheet lamination type piezoelectric elements are in a form of prism shape.

35. The ultrasonic levitation device as claimed in any one claim of claims 27 to 34, wherein:

10 said movable part further comprising a movable part body through pillar members, in a form that said pillar members are positioned substantially at the center of said vibrators or substantially at the center of said vibrating direction changing means.